Evolutionary Phases of Gas-rich Galaxies in a Galaxy Cluster at z=1.46

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Gas content of galaxies is one of fundamental quantities directly related to the star-formation activities in galaxies. Since it is expected that star-forming galaxies in high-z galaxy clusters grow to massive early-type galaxies in the local Universe, the cluster galaxies' gas content should allow us to better understand the quenching mechanisms of galaxies in dense environments.

We conducted a survey of molecular gas in galaxies in the XMMXCS J2215.9-1738 cluster at z=1.46 with ALMA. We have detected emission lines from 17 galaxies within a radius of R_{200} from the cluster center, in Band 3 data with a coverage of 2.33 arcmin^2. The lines are all identified as CO J=2–1 emission lines from cluster members at $z\sim$1.46 by their redshifts and the colors of their optical and near-infrared counterparts. This is the largest sample of CO emission-line galaxies associated with a $z>1$ galaxy cluster to date.

The spatial distribution of galaxies with CO(2–1) detected suggests that they disappear from the very center of the cluster (Figure 1). The phase-space diagram showing relative velocity versus cluster-centric distance indicates that the gas-rich galaxies have entered the cluster more recently than the gas-poor star-forming galaxies and passive galaxies located in the virialized region of this cluster (Figure 2). The results imply that the galaxies have experienced ram-pressure stripping and/or strangulation during the course of infall towards the cluster center and then the molecular gas in the galaxies at the cluster center is depleted by star formation. Refer to [1] for further discussion.

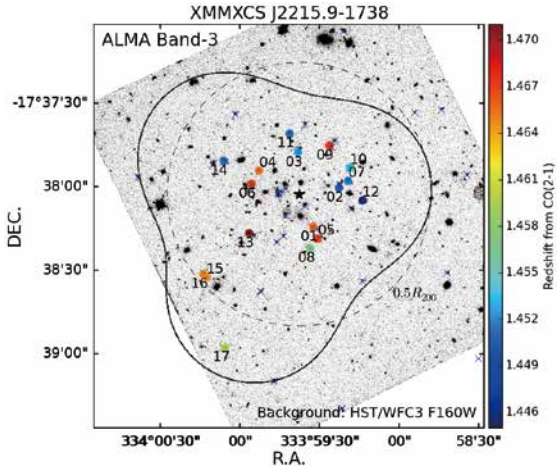

Figure 1: Spatial distribution of galaxies with CO(2–1) line detected which are shown by filled circles. The solid curve shows a region where the ALMA Band 3 data are available. The cross symbols show the [O II] emitters associated with this cluster [2]. A star symbol shows a cluster center [3]. The dashed circle shows the cluster-centric radius of 0.5R_{200} [4].

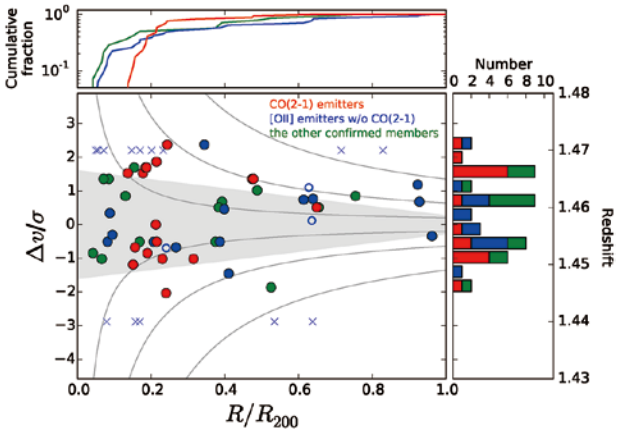

Figure 2: Phase-space diagram showing the relative line-of-sight velocities as a function of cluster-centric distance. Red circles show the CO(2–1) emitters. Blue symbols show the [O II] emitters without CO(2–1) detection. Green circles show the other spectroscopically confirmed cluster members [4,2]. The gray region shows a virialized area defined by [5]. The gray lines show the curves of constant $v \times R$ values [6]. (right panel) Redshift histograms of spectroscopically confirmed galaxies. (upper panel) Cumulative fraction of the number of galaxies as a function of radius from the cluster center.

References

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